



MANUAL

SERIES **NC**[®] STEEL DOUBLE-FLOW[®]

Operation and Maintenance Instructions

MAY, 1981

OM-NC-J

5800 Foxridge Drive – Mission, Kansas 66202

PRINTED
IN
U.S.A.

MANUAL 92 - 1330

OPERATION & MAINTENANCE INSTRUCTIONS – SERIES NC STEEL DOUBLE-FLOW

SERIES NC STEEL DOUBLE-FLOW

TABLE OF CONTENTS

Pre-starting Instructions	page 3
Starting Instructions	page 3
Operation	page 3
Tower Maintenance	page 4
Water Treatment	page 5
Inspection & Maintenance Schedule	page 5
Spare Parts	page 6
Seasonal Shutdown Instructions	page 6
Fan Removal	page 6
Recommended Motor Conduit Installation	page 7
Fan Installation	page 8
Motor Removal	page 8
Motor Installation	page 8
Geareducer Removal	page 10
Geareducer Installation	page 10
Louver Installation	page 11
Tower Trouble Tips	pages 11 & 12
Mechanical Equipment Operating Position	page 13

— IMPORTANT —

Always refer to tower serial number in any correspondence. Serial number is stamped on the Marley nameplate located on or above the tower access door.

SERIES NC[®] STEEL DOUBLE-FLOW[®]

Operation and Maintenance Instructions

GENERAL

NOTE: The cooling tower must be located at such distance and direction from any air conditioning or ventilating system air intake ducts as to be safe with respect to fire or clean air considerations. It is recommended that the purchaser obtain the services of a Licensed Professional Engineer or Registered Architect to certify that the location of the tower is safe and in compliance with applicable air pollution and fire codes and clean air considerations.

These instructions have been prepared to assist the tower owner and operator in obtaining the best results and long life from his Marley tower. Service manuals on mechanical equipment and parts manual sheets are sent with these instructions and should be read before the tower is put in service.

Any questions concerning the operation and/or maintenance not covered by these instructions should be referred to the nearest Marley representative. *When writing for information or ordering parts, always mention tower serial number shown on the nameplate.*

PRE-STARTING

When a cooling tower is started for the first time or after a long shut down period, it should be cleaned and inspected. All operating assemblies must be inspected before they are placed in operation. Following is a list of functions to be performed before starting the tower:

1. Remove items shipped in cold water basin and install per installation drawings shipped with tower.
2. Models 8608, 8609, 8610 and 8614 ship with detached top fan cylinder ring and lowered mechanical equipment. See page 13 for important installation instructions.
3. Clean any dirt, leaves or foreign matter from the hot water basins, cold water basin and air inlet louvers. See that metering orifices in hot water basins are in place and open. Remove any debris from suction screen and sump in the cold water basin. See that sump screens are installed properly.
4. Wash down the fill assembly and tower basins, and drain to remove accumulated debris. Use low pressure water stream.
5. Before operating the motor, check that overload protection has been installed in all three lines. Overloads should be at the same ambient temperature as the motor. Do not use ambient compensated overloads. Also, check the wiring system for grounds and check the resistance between all leads for open, bad or incorrect connections. (See installation section of Marley Service Manual on Electric Motors.)
6. Check motor bearings for grease. Motors are lubricated for initial operation by the motor manufacturer, however, the motor bearing housing should be

examined for presence of adequate grease before motor is placed in operation. Use grease recommended by the motor manufacturer. Chevron SRI-2 is recognized by many motor manufacturers as a suitable grease for ball bearing motors on cooling tower service. Refer to Marley Electric Motor service manual for greasing procedure.

7. Test motor insulation resistance with a "megger". (See maintenance section of Marley Service Manual on Electric Motors.)
8. Check oil in Geareducer by draining off a sample and examining for water. Drain, flush and refill with oil if water is present. Check Geareducer and oil line fittings for leakage and correct as required. Add oil if level is low. *Check oil level at external sight glass or dip stick to be sure full mark corresponds with full level in Geareducer.* (See Geareducer Service Manual.)
9. Check the fan for free rotation and ample tip clearance. Clearance between the ends of the blades and the cylinder should be a minimum of 1/8".
10. Be sure float valve for make-up water is operating freely.
11. Check, and tighten as necessary, structural bolting in mechanical equipment supports, Geareducer mounting bolts, and close coupling set screws.

STARTING

FILLING THE WATER SYSTEM

Fill the cold water basin and connected pipe system with water until the operating water level is reached. (See "Operation — Cold Water Collecting Basin" page 4.) The float valve should be adjusted to maintain water at the required level, then basin should be filled to overflow level.

Open the hot water valve; then prime and start the circulating water pump. The water depth in the hot water basins should be between 2 and 5 inches.

STARTING THE FAN

Fan must run clockwise when viewed from above and discharge the air up. Directional arrows on the fan blades show the proper rotation.

If the motor is not loaded in accordance with the contract horsepower, adjust fan blade pitch. (See operation section of Marley Service Manual on Electric Motors and Fan Service Manual.)

OPERATION

FAN DRIVE

If a two speed motor is used, allow a time delay of a minimum of 20 seconds after de-energizing the high speed winding and before energizing the low speed winding. Tremendous strains are placed on driven ma-

chinery and motor unless the motor is allowed to slow to low speed rpm or less before the low speed winding is energized. When changing fan direction of rotation, allow a minimum of two minutes time delay before energizing the fan motor.

HOT WATER DISTRIBUTION BASINS

To obtain maximum performance, maintain equal water flow and distribution over the basins. If all the metering orifices are clean and in place, equal water depth (2 to 5 inch(es) in both basins will indicate even distribution. If a major change in the quantity of water circulated over the tower is made, it may be desirable to change the orifice size to provide adequate water break-up and maintain the proper water level. Consult the Marley sales office or representative in your area if a change in circulating water rate is being considered.

COLD WATER COLLECTING BASIN

Normal operating water level in the collecting basin at bottom of tower is 1½ to 2 inches of water in the basin area under the fill. Maintain sufficient depth to prevent air from entering suction line under normal operation, but not so deep that water is lost out overflow when tower is shut down.

A tower with a concrete basin should have the operating water level 0 to 1½ inches below the fill. Special low operating depths of water may be accommodated by the use of air baffles under the fill to prevent air bypass.

WATER MAKE-UP AND BLEED-OFF

The volume of make-up water that is required to maintain adequate water depth in the cold water collecting basin depends upon the evaporation loss, drift loss and bleed-off. Water for make-up averages 1½ % of the tower water circulated for a cooling range of 10°F. For additional information see section on "Water Treatment", page 5.

WINTER OPERATION

During periods of low temperature operation (36° to 40°F and below), ice will form on the relatively dry parts of the tower that are in contact with the incoming air. Primarily, this includes the louvers and adjacent structural framing.

Ice forming characteristics on any given tower will vary, depending on velocity and direction of wind, circulating water rate and heat load. Ice formation may be controlled by regulating air and water flow through the tower by one or more of the following procedures:

1. Shut down the fan. This reduces the cooling rate to a minimum and increases the quantity of warm water on the louvers to a maximum. Except for extreme cold conditions or extended freezing conditions, this procedure will normally control ice formation. For automatic operation, a timer switch can be provided to shut the fan down for a few minutes each hour.
2. If the tower has two-speed motors, operate the fan at half speed forward. This reduces the cooling rate (heat transfer) and increases the quantity of warm water on the louvers.

Under extended extreme cold conditions, it may be necessary to operate the fan in reverse. This forces warm air

out through the louvers, melting any accumulated ice. Reversal may be at either full or half speed, however, full speed is recommended. Reverse operation of the fan should only be used to eliminate ice, not prevent it. *Reverse fan operation should not exceed 15 to 20 minutes.* Usually much less time than this is required to melt accumulated ice.

Avoid prolonged reverse operation of the fan since ice will build up on the blade tips or fan cylinder with resultant damage, and the moist air out through the louvers can create an accumulation of ice on surfaces exterior to the tower at the louvers.

See "Operation — Fan Drive", page 3, for fan speed change and reversing precautions.

INTERMITTENT WINTER OPERATION

When the cooling tower is operated intermittently during winter weather, it is necessary that the water be drained from the exposed piping and tower basin to insure protection against freezing and possible pipe rupture. Basin drains should be left open during winter shutdown periods to allow rain and melted snow to escape.

If tower has oil gage and drain lines, check for condensate and drain as required. (See Geareducer Service Manual.)

TOWER MAINTENANCE

Maximum performance and service life depends on inspection and maintenance of all parts of the tower and its supply system. In most cases, a general tower inspection once a day should be sufficient. The schedule in Table I can be used by the operator to obtain continuously good performance with the least tower maintenance. Marley recommends setting up a regular inspection schedule to insure effective safe operation of the cooling tower. Keep continuous lubrication and maintenance records for each cooling tower. Regular inspection and repair of personnel safety items, indicated by asterisk in Table I, and a record of same is especially important. "SAFETY FIRST".

HOT WATER DISTRIBUTION BASINS

Metering orifices in the bottom of the hot water basin may be cleaned without shutting down any part of the tower. Remove dirt, algae, leaves, etc., which might get in basins or orifices. Orifices must be in place to assure proper water distribution.

BASIN COVERS (OPTIONAL)

Cooling tower distribution basin covers are not designed for use as a walking surface or working platform. If cooling tower has distribution basin covers, decals have been installed on the tower to instruct personnel on top of tower not to use them as a walking surface or working platform. These decals read CAUTION: DO NOT USE BASIN COVERS AS A WALKING SURFACE OR WORKING PLATFORM. Maintain or replace decals as required to retain their legibility.

COLD WATER COLLECTING BASIN

The water level in the cold water basin should be checked daily. Inspect the suction screen each week, cleaning away any accumulated debris. Float valves or make-up water con-

TABLE I

INSPECTION & MAINTENANCE SCHEDULE
General Recommendations

(More frequent inspection and maintenance may be desirable)

	FAN AND FAN GUARD	MOTOR	COUPLING	GEAREDUCER	DISTRIBUTIONS BASINS	FLOW CONTROL VALVES (OPT.)	COLD WATER BASIN	FLOAT VALVE	SUCTION SCREEN	DRIFT ELIMINATORS	FILL	STRUCTURAL MEMBERS	CASING	LADDERS & HANDRAILS*
1. Inspect for clogging					W				W	W	W			
2. Check for unusual noise or vibration	D	D	D	D								Y		
3. Inspect keys and set screws	S	S	M	S										
4. Lubricate (grease)		R				S								
5. Check oil seals				M										
6. Check oil level				W										
7. Check oil for water and sludge				M										
8. Change oil, at least				S										
9. Check water level					D		D							
10. Check for leakage				W	S		S	S						
11. Inspect general condition	M	S	M	S	S	S	Y	Y	S	Y	S	S	Y	S
12. Tighten loose bolts	S	S	M	S								S	R	
13. Clean	R	S		R	R	R	S	R	W	R	R			
14. Repaint	R	R		R										
15. Completely open & close						S								
*16. Inspect and repair for safe use	Y													Y

D-daily; W-weekly; M-monthly; Q-quarterly; S-semi-annually; Y-yearly; R-as required

trols should operate freely and maintain the proper water level.

FILL

The fill must be kept clean. It is easier to prevent the deposition of foreign material than to remove it later. This is covered more completely in the "Water Treatment" section of this manual.

ELECTRIC MOTOR

Remove any oil, dust or scale deposits from the motor. They can cause excessive insulation temperatures.

Lubricate the motor in accordance with the manufacturer's recommendations.

Refer to Marley Electric Motor service manual for maintenance and lubrication information.

GEAREDUCER

Geareducers supplied with new towers are filled with oil. Lubricating oil is not furnished with Geareducers supplied as spares or on replacement orders.

Check oil level before start-up and make sure there are no oil leaks.

Run Geareducer at full speed, full load for one week or 150 hours. Change oil after this initial break in period to remove any foreign matter. See Geareducer Service Manual for recommended lubricants and instructions for changing oil.

Change oil at least every six months or 3000 hours of operation.

FAN

Check fan operation daily. Inspect blades monthly and clean if necessary. (See Fan Service Manual.)

FLOW CONTROL VALVES

If tower has optional inlet valves by Marley, grease valve threads at zerk fitting semi-annually using rust inhibiting lithium base grease of NLGI No. 2 consistency.

PAINTING

All metal parts subject to corrosion and not galvanized should be cleaned and painted periodically with rust-resistant paint. Bitumastic base paints are good for this. The actual time between paintings is dependent upon the operating cycle, water conditions and climatic conditions.

WATER TREATMENT

BLEED-OFF

Bleed-off is the continuous removal of a small portion of the water from the circulating system. The purpose of bleed-off is to prevent dissolved solids from concentrating to the point where they will form scale. As a guide, many waters can be allowed to concentrate two or three times without causing scale problems. The amount of bleed-off to hold concentrations to two or three depends upon the cooling range (hot water temperature minus cold water

temperature). The following table shows amount of bleed-off required at three different cooling ranges.

COOLING RANGE (DEGREES F)	% OF CIRCULATING RATE TO BLEED-OFF TO MAINTAIN THREE CONCENTRATIONS	% OF CIRCULATING RATE TO BLEED-OFF TO MAINTAIN TWO CONCENTRATIONS
5	.18	.38
10	.38	.78
15	.58	1.18

EXAMPLE: 1200 GPM circulating rate, cooling range 10°F. To maintain three concentrations, the required bleed-off = $1200 \times .0038 = 4.6$ GPM

CHEMICAL TREATMENT

The quality of many waters is such that chemical treatment for scale prevention or removal will not normally be required if adequate bleed-off is maintained. In areas where bleed-off alone is not sufficient to prevent objectionable scale or corrosion, use a simplified phosphate treatment or contact a reputable water treatment company for aid.

Slime, a gelatinous organic growth, and algae, a green moss, may grow in the cooling tower or heat exchangers. Their presence can interfere with cooling efficiencies. Proprietary compounds are available from water treating companies for the control of slime and/or algae, however, compounds which contain copper must be used with care. Copper can accelerate corrosion of steel, iron, aluminum and galvanizing and should not be used in systems containing any of those materials. Chlorine and chlorine containing compounds are effective algacides and slimicides but excess chlorine can damage wood and other organic materials of construction. If used, chlorine should be added as intermittent (or shock) treatment only as frequently as needed to control the slime and algae, and free residual levels should not exceed one part per million parts water (1 ppm). Chlorine or chlorine containing compounds should be added carefully since very high levels of chlorine occur at or near the point of entry into the circulating water system.

FOAMING

Foaming occasionally becomes a problem with certain water conditions when a new tower is put into operation. The condition is not normally persistent for an extended period, and foaming can be lessened by increasing bleed-off until condition is improved. If increased bleed-off does not lessen foaming sufficiently, a foam depressant chemical should be used. These are generally available through local chemical supply companies and some water treating companies.

SPARE PARTS

Marley maintains a stock of replacement parts for mechanical equipment at Olathe, Kansas. Shipment of these parts is normally made within ten days after an order is received. If emergency service is necessary, contact the Marley sales office or representative in your area for assistance.

To prevent prolonged shutdown periods in case of damage

to mechanical equipment, it is suggested that the following spare parts be carried in the owner's stock:

1. One fan assembly.
2. One Geareducer assembly.
3. One close coupling assembly.

Be sure to furnish the tower serial number when ordering any parts.

SEASONAL SHUTDOWN INSTRUCTIONS

Drain the tower basins and all the exposed piping. Leave the basin drain open.

During shutdown, clean the tower and make any necessary repairs. Apply protective coating as required to all metal parts. Particular attention should be given to mechanical equipment supports.

GEAREDUCERS

1. At shutdown, operate Geareducer until oil is warm; drain and refill. (See the lubrication section of Geareducer Service Manual for instructions on changing oil.)
2. Each month, drain water condensate from the lowest point of the Geareducer and, if tower is so equipped, from its oil system. Check oil level at Geareducer and add oil if necessary. Operate to re-coat all interior surfaces with oil.
3. At start-up, operate until oil is warm; drain and refill.

FLOW CONTROL VALVES

If tower has optional inlet valves by Marley, grease valve threads at zerk fitting using rust inhibiting lithium base grease of NLGI No. 2 consistency and then open valve.

ELECTRIC MOTORS

Clean and lubricate motor at close of each operating season. Refer to motor manufacturer's recommendations.

Do not start motor without determining that there will be no interference with free rotation of the fan drive.

The motor should be run for three hours at least once a month. This serves to dry out windings and relubricate bearing surfaces. Refer to Marley Electric Motor service manual.

At start of new operating season, make sure bearings are adequately lubricated before returning motor to service.

PROLONGED SHUTDOWN

If shutdown period is longer than seasonal, contact the Marley sales office or representative in your area for additional information.

FAN REMOVAL

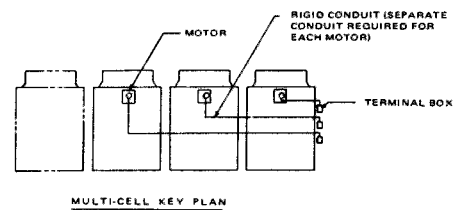
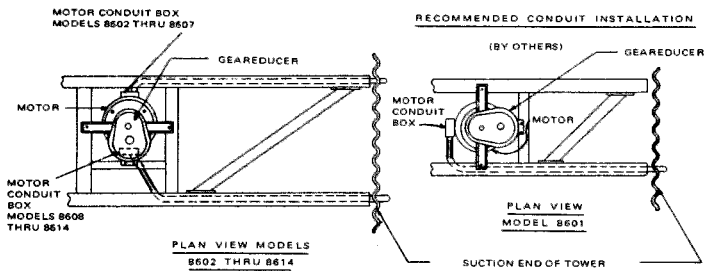
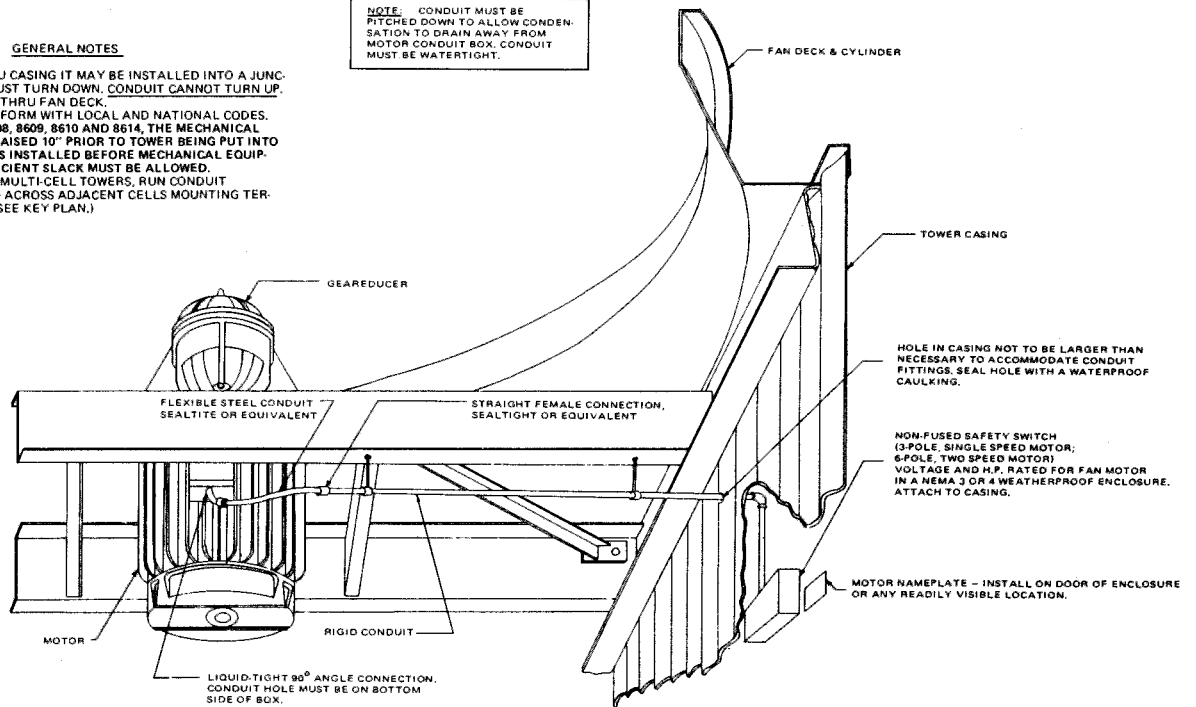
1. Disconnect power to motor. Remove fan guard.
- 2A. Towers with Type H-3 fans:
(Fan type is shown on the fan nameplate attached to

RECOMMENDED MOTOR CONDUIT INSTALLATION

GENERAL NOTES

1. ONCE CONDUIT IS THRU CASING IT MAY BE INSTALLED INTO A JUNCTION BOX. CONDUIT MUST TURN DOWN. CONDUIT CANNOT TURN UP.
2. DO NOT RUN CONDUIT THRU FAN DECK.
3. ALL WIRING MUST CONFORM WITH LOCAL AND NATIONAL CODES.
4. ON TOWER MODELS 8608, 8609, 8610 AND 8614, THE MECHANICAL EQUIPMENT MUST BE RAISED 10" PRIOR TO TOWER BEING PUT INTO SERVICE. IF CONDUIT IS INSTALLED BEFORE MECHANICAL EQUIPMENT IS RAISED, SUFFICIENT SLACK MUST BE ALLOWED.
5. ON INTERIOR CELL OF MULTI-CELL TOWERS, RUN CONDUIT THROUGH CASING AND ACROSS ADJACENT CELLS MOUNTING TERMINAL BOX ON CELL. (SEE KEY PLAN.)

NOTE: CONDUIT MUST BE FITTED DOWN TO ALLOW CONDENSATION TO DRAIN AWAY FROM MOTOR CONDUIT BOX. CONDUIT MUST BE WATERTIGHT.



the fan hub.)

Type H-3 fans may be disassembled for removal from fan cylinder or removed as assemblies. The latter is suggested since blade pitch angle will not be disturbed and these fan assemblies are light enough to be handled by two men.

- (1) If Geareducer has hollow fan shaft, remove dip stick.
- (2) Loosen set screw in center hub of 54" diameter H-3 fan or remove hub retaining nut on 72", 84" and 96" diameter H-3 fans.
- (3) Remove fan from Geareducer fan shaft using a two or three-legged hub puller (protect end of shaft with a flat steel plate while using hub puller).
- (4) If fan has cast iron hub, avoid damaging fan blade shank insulation. (See Fan Service Manual.)

- 2B. Towers with Type H-5 fans:
(Fan type is shown on the fan nameplate attached to the fan hub.)

72", 84" and 96" diameter H-5 fans are more easily handled by components than as assemblies for removal from cylinder.

- (1) If Geareducer has hollow fan shaft, remove dip stick.
- (2) Remove top hub cover (flat portion) and top hub cover skirt. It will be necessary to slightly deflect the skirt to lift it past the blade edges.
- (3) Note blade pitch angle and remove blades and blade clamps.
- (4) Remove tap screws in bottom skirt and let skirt rest on Geareducer.
- (5) Drive four dowel pins through the aluminum fan hub into the fan hub bushing on Geareducer fan shaft. Remove the four cap screws and remove fan hub. Care should be taken not to damage or lose the zinc shim between the aluminum fan hub and bushing.
- (6) Remove bottom hub skirt.
- (7) Remove the fan hub bushing from Geareducer fan shaft using a hub puller (protect end of

shaft with a flat steel plate while using hub puller).

- (8) **CAUTION.** If fan is removed from the cylinder as an assembly using hoisting equipment, do not wrap chains, chokers, ropes, etc., around or under the hub cover skirts. Remove the top hub cover and sling through the hub spokes for hoisting.

FAN INSTALLATION

1. Clean fan hub bore and Geareducer fan shaft with solvent. Remove any burrs which might interfere with proper hub to shaft fit. Coat the fan shaft with a thin film of light oil.
- 2A. Towers with Type H-3 fans:
Install fan. Reverse procedures used during fan removal. If fan has been disassembled, refer to H-3 Fan Service Manual for assembly details.
- 2B. Towers with Type H-5 fans:
 - (1) Install fan hub bushing on Geareducer fan shaft and secure with hub retaining nut. If Geareducer has hollow fan shaft, insert dip stick.
 - (2) Attach bottom hub cover skirt to aluminum fan hub, place zinc shim on fan hub bushing and install hub on bushing (do not omit zinc shim). Insert dowel pins and tighten the four cap screws to 40-50 ft./lbs. torque. Do not lubricate these cap screws.
 - (3) Install fan blades as follows:
 - a. Lubricate blade clamp stop nuts (threads and bearing surfaces) with a mixture of 50% petrolatum and 50% graphite by weight. Do Not Install This Hardware Without The Lubricant.
 - b. Install a fan blade and adjust to recommended pitch angle. (See H-5 Fan Service Manual.) Tighten blade clamp stop nuts to 140-150 ft./lbs. torque. It Is Important That These Stop Nuts Are Properly Lubricated And Tightened.
Select a reference point on the inside surface of the fan cylinder and mark the elevation of the leading edge of the fan blade tip. This will serve as a guide for installation of the remaining three blades.
 - c. Install remaining three blades such that blade tips are within 1/8", vertically, of the reference point on the cylinder marked from the first blade. This is to provide satisfactory operating balance of the fan assembly.
 - (4) Recheck fan blade pitch angle and blade clamp stop nut torque.
 - (5) Install top hub cover skirt and top cover.
3. Check fan blade tip clearance. Minimum recommended tip clearance is 1/8". Adjust Geareducer if necessary to obtain desired tip clearance. Rotate fan by hand to be sure there are no obstructions to free rotation.

4. Replace fan guard. Restore power to motor.
5. Start motor and check fan rotation. Correct rotation is clockwise when viewed from the top of the tower looking down at the fan.

MOTOR REMOVAL

Note: The motor and Geareducer can be removed as one unit and taken to a work bench for service. This operation is outlined under "Geareducer Removal". The following is for motor removal only:

1. Drain water from tower cold water basin.
2. Disconnect conduit and wiring at motor. Remove fan guard.
3. All models except the 8601 through 8605 require a ladder for access to motor flange bolts or cap screws.
4. Planks placed across the cold water basin and resting on the basin sides will be helpful in moving the motor in and out of the tower. The planks should be strong enough to carry the weight of two men plus the motor.
5. Rig hoist to support motor. This will vary with the equipment available and jobsite conditions. The arrangement shown in illustrations A and B is suggested. See page 9.
- 6A. On Models 8601 through 8607 with Series 11T or 11.1 Geareducers, the close coupling halves on motor and Geareducer shafts are not bolted together; the coupling halves will separate when motor is lowered. Remove coupling insert for safekeeping.
- 6B. On Models 8608 through 8614 with Series 21.1T Geareducers, remove the coupling access cover on the side of the Geareducer case. The Series 21.2 Geareducer case opening allows direct access to the close coupling. Remove the four 5/8" cap screws and lock washers securing the two close coupling halves together.
Note: A 3/8" hex socket is provided in the motor end of bonded rubber bushings in motor half of coupling. A 3/8" Allen wrench can be used to prevent bushings from turning in their sockets while loosening or tightening cap screws.
7. Check hoisting equipment. Make sure it is securely fastened to the motor. In the next step the entire weight of the motor is transferred to the hoist.
8. Remove the four bolts or cap screws connecting the Geareducer and motor flanges. Lower the motor straight down until the motor coupling half clears the base of the Geareducer.
9. Guide motor through the access opening in tower casing and lower to the ground or work platform.
10. If motor is to be replaced or taken to the service shop, remove the motor coupling half from the shaft. A hub puller will be required to remove the coupling half. *Do not hammer or beat on any part.*

MOTOR INSTALLATION

Note: When 7½ H.P. or 10 H.P. motor with 254 TCV or 256 TCV frame is used on a Series 11T or 11.1 Geareducer,

TWO HOIST SUPPORTS—SPACERS ARE REQUIRED BETWEEN SUPPORTS AND TOP OF FAN CYLINDER TO PROVIDE OPERATING CLEARANCE FOR HOISTS AND TO PREVENT CRUSHING OF THE FAN CYLINDER TOP RING.

ILLUSTRATION A

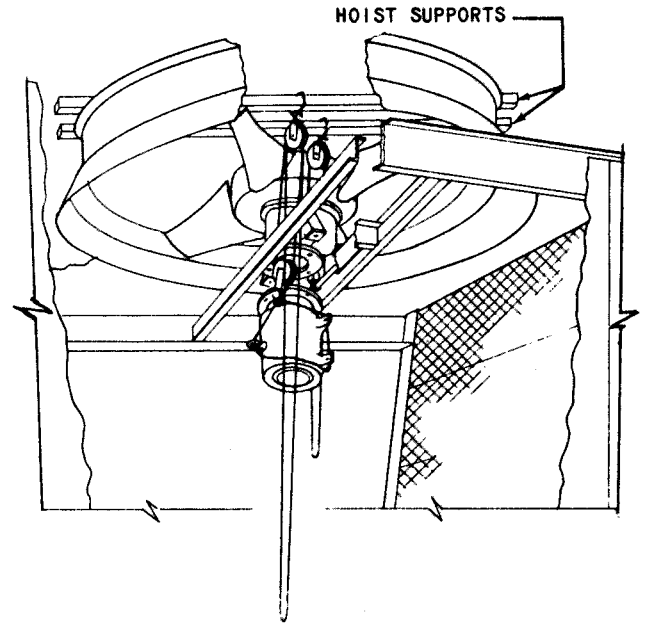
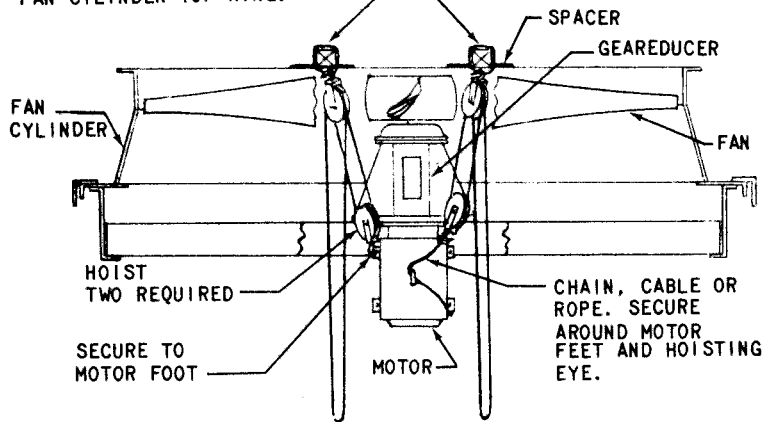
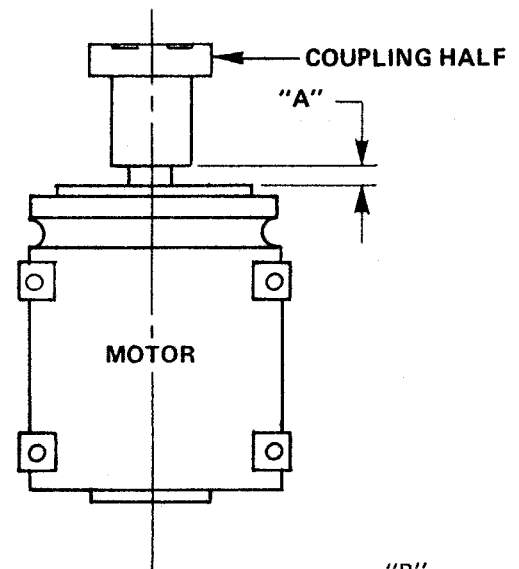


ILLUSTRATION B

3/8" must be cut off end of motor shaft. If motor is purchased and furnished by Marley, the shaft is already cut off. Frame 254 TCV or 256 TCV motor requires 1-5/8" Ø bore in motor half of close coupling.

1. Rig hoisting equipment.
2. Clean the machined faces and pilot diameters of the motor and Geareducer flanges. These surfaces control alignment of motor shaft to Geareducer pinion shaft.
3. If motor coupling half was removed, it should be installed on motor shaft at this time. Clean motor shaft and yoke bore and coat motor shaft with "Thred-Gard" (Crane Packing Co.) or similar lubricant. *Do not* drive coupling half on to shaft as this can damage the motor bearings. Position coupling half per "A" dimension shown in illustration C. Tighten set screw lightly.
4. Guide motor through the access opening in tower casing. If tower has Series 11T or 11.1 Geareducer, install the coupling insert on the motor coupling half.
5. Guide the motor into position until the machined surfaces on the motor and the Geareducer flanges are together and the bolt holes are aligned. On the Series 11T or 11.1 Geareducer, rotate the Geareducer coupling half so the jaws can engage the coupling insert. Use care during this step of the assembly. *Do not* force or drive parts into assembly.
6. Install cap screws and lock washers (Series 11T or 11.1 Geareducer), or bolts, nuts and lock washers (Series 21.1T or 21.2 Geareducer), through the Geareducer flange and into the motor flange. Tighten fasteners to 65 ft./lbs. torque for Series 11T or 11.1 and 220-230 ft./lbs. for Series 21.1T or 21.2.
7. Hoisting equipment can now be removed.
- 8A. On Series 11T or 11.1 Geareducer, adjust motor half of close coupling to obtain 1/64 to 1/32 inch gap between jaw faces of motor and Geareducer coupling halves. Axial clearance is required to prevent imposing thrust loads on Geareducer and motor bearings. Tighten both set screws in motor coupling half to "B" in./lbs. torque per illustration "C". Check



GRDR	MOTOR FR.	"A"	"B" SET SCREW TORQUE INCH/LBS.
11T or 11.1	182TCV, 184TCV 213CV, 215CV	1	150
11T or 11.1	213TCV, 215TCV 254UCV, 256UCV	1-1/2	150
11T or 11.1	254TCV, 256TCV	1-3/8	215
21.1T	254 & 256TCV or UCV	1/2	120
21.1T	284 & 286TCV or UCV	1-3/4	120
21.2	ALL	3/8	120

ILLUSTRATION C

to see that both set screws in Geareducer coupling half are tightened to required torque per illustration "C", page 9.

- 8B. On Series 21.1T or 21.2 Geareducer, rotate close coupling halves so the balance matchmarks (numeral 1) on the edge of both coupling halves are aligned. Some close couplings do not have matchmarks. Balance of these couplings is not affected by relative position of the coupling halves. Adjust motor coupling half so that the threaded ends of the bonded rubber bushings clear the face of the Geareducer coupling half by .010 inch. Axial clearance is required to prevent imposing thrust loads on Geareducer and motor bearings. Tighten the set screw in the motor coupling half to "B" in./lbs. torque per illustration "C". Check to see that the set screw in the Geareducer coupling half is tightened to required torque per illustration "C". *After* motor and Geareducer coupling half set screws have been tightened to required torque, install 5/8" diameter cap screws and lock washers through the Geareducer coupling half and into the threaded bushings. Tighten cap screws to 95-105 ft./lbs. torque. Hold bushings with 3/8" Allen wrench if necessary to prevent turning.
9. Rotate fan and check that it rotates freely.
10. Replace fan guard. Connect wiring and conduit to the motor.
11. Fill water circulating system to operating level.
12. Start motor and check fan rotation. Correct rotation is clockwise when viewed from the top of the tower looking down at the fan.

GEAREDUCER REMOVAL

Note: Geareducer and motor can be removed as one assembly. If hoisting equipment is available, it is recommended this method be used for motor removal. It allows bench assembly of motor to Geareducer and eliminates standing under the motor and reaching overhead to make close coupling and bolting connections.

1. Drain water from tower cold water basin.
2. Disconnect conduit and wiring at motor. Remove fan guard.
3. Remove fan (see "Fan Removal").
4. Drain oil from Geareducer. If tower has the optional extended oil fill and drain line, disconnect oil line coupling located on the end of the flexible oil hose.
5. Remove Geareducer and motor assembly mounting bolts.

Note: The Series 11T Geareducer mounts on a welded steel adaptor bolted to the tower mechanical equipment support. Disconnect adaptor from equipment support and remove from tower with Geareducer and motor assembly.

The Series 11.1 Geareducer with extended mounting feet bolts directly to the tower mechanical equipment support and does not require the separate mounting adaptor.

Series 21.1T or 21.2 Geareducers bolt directly to the tower mechanical equipment support.

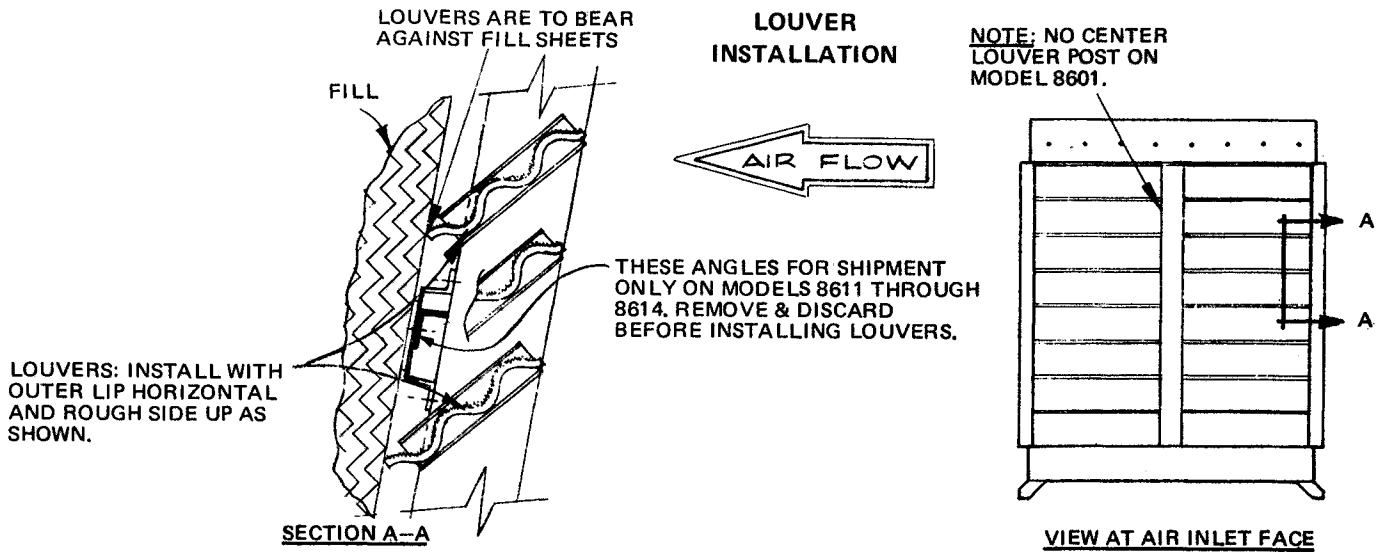
6. On some motors it may be necessary to remove the motor hoisting eye and one cross-support member before the motor can be lifted between the equipment support rails.
7. Sling firmly around Geareducer and hoist Geareducer and motor assembly up out of fan cylinder and lower to the ground.
8. If Geareducer only is to be serviced, refer to maintenance instructions in Geareducer Service Manual. Most of the service and maintenance can be performed without removing the motor from the Geareducer.
9. If motor is to be removed from Geareducer, follow steps 6 through 10 under "Motor Removal", page 8.

GEAREDUCER INSTALLATION

1. Bolt welded steel adaptor to Series 11T Geareducer. (Adaptor is not required with Series 11.1 Geareducer.)
2. If motor has been removed, it should now be installed on the Geareducer. Follow steps 2 through 8 of "Motor Installation", page 9.
Note: Check the position Geareducer and motor assembly will occupy in tower and attach motor so that conduit box will clear mechanical equipment support members and line up with any existing conduit.
3. Install all drain plugs in the Geareducer. *Do not* fill with oil at this time.
4. Attach slings to Geareducer and motor assembly. Remove motor hoisting eye if necessary due to space requirements.
5. Hoist assembly up over the fan cylinder and lower into position between the two equipment support channels.
6. Insert Geareducer and motor assembly mounting bolts and install nuts and lock washers finger tight only at this time.
7. Install fan. Follow procedure under "Fan Installation".
8. Center the fan in the fan cylinder by moving the Geareducer and motor assembly on the equipment support. Minimum recommended fan blade tip clearance is 1/8".
9. When the fan is centered, tighten Geareducer and motor assembly mounting bolts. Tighten 1/2" bolts to 65 ft./lbs. torque, 5/8" bolts to 135 ft./lbs. Rotate fan and check that it rotates freely.
10. If tower has oil gage and drain line, re-connect oil line piping and check connections for leaks after oil has been added.
11. Add oil to the Geareducer. See list of recommended oils in Geareducer Service Manual. Fill Geareducer with oil through elbow or fill hole on side of case, or, if so equipped, through opening in top of fan shaft. If tower is equipped with optional oil gage and drain line, the Geareducer may be filled through the oil line at the fan deck. Adjust fan deck dip stick or sight gage placard to agree with full oil level mark at the Geareducer. *Regardless of the procedure used, the Geareducer must be filled to the full oil level mark.*
12. Replace fan guard. Connect wiring and conduit to the motor.
13. Fill water circulating system to operating level.
14. Start motor and check fan rotation. Rotation is clockwise when viewed from top of the tower, looking down

at fan.

- After operating fan for five minutes, stop fan and check Geareducer for oil leaks. Tighten any loose bolts, plugs or oil line connections.



TOWER TROUBLE TIPS

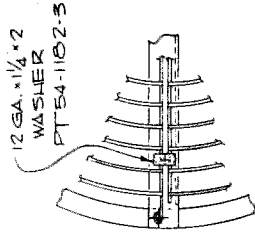
TROUBLE	CAUSE	REMEDY
Excessive Water Drift	Faulty drift elimination	<ol style="list-style-type: none"> 1. Check to be sure all louvers and eliminator sections are in place. 2. Metering orifices of hot water basins must be in place and clean of debris. 3. There must be no leaks under hot water basin sides.
	Overpumping	Reduce water flow to tower to design conditions or use larger basin orifices. Excess water flow will cause overflowing onto fan deck and into fan cylinder.
Cold Water Too Warm	Overpumping	Reduce water flow to tower to design conditions.
	Not enough air	Check motor current and voltage to be sure of correct contract horsepower. Clean louvers, fill and eliminators.
Unusual Motor Noise	Motor running single-phase	Stop motor and attempt to start it. Motor will not start if single-phased. Check wiring, controls and motor.
	Electrical unbalance	Check voltage and current of all three lines. Correct if required.
	Ball bearings	Check lubrication. Replace bad bearings.
Motor Runs Hot	Motor overload, wrong voltage or unbalanced voltage	Check voltage and current of all three lines against nameplate values.

TOWER TROUBLE TIPS (continued)

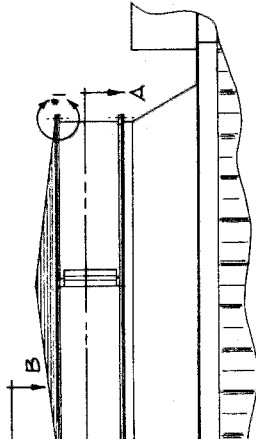
TROUBLE	CAUSE	REMEDY
Motor Runs Hot (continued)	Bearings overgreased	Remove grease reliefs. Run motor up to speed to purge excessive grease.
	Poor ventilation	Clean motor and check ventilation openings. Allow ample ventilation around motor.
	Incorrect Grease	Change to proper grease. See motor manufacturer's lubricating instructions and Marley electric motor manual.
	Winding fault	Check with ohmmeter.
	Incorrect fan blade pitch	Measure actual fan pitch and compare to that recommended. Correct if necessary. See Fan Service Manual.
	Too frequent starting	Limit accumulative starting time to a total of 30 seconds each hour.
Geareducer Noise	Gears	Correct tooth engagement. Replace badly worn gears. Replace gears with imperfect tooth spacing or form.
	Geareducer bearings	If new, see if noise disappears after one week of operation. Drain, flush and refill Geareducer. See Geareducer Service Manual. If still noisy, replace.
Unusual Fan Drive Vibration	Loose bolts and cap screws	Tighten all bolts and cap screws on all mechanical equipment and supports.
	Unbalanced fan	Be sure blades are properly positioned in correct sockets. (See match numbers.) Make certain all blades are as far from center of fan as safety devices permit. All blades must be pitched the same. See Fan Service Manual. Clean off deposit build-up on blades.
	Worn Geareducer bearings	Check fan and pinion shaft endplay. Replace bearings as necessary.
	Unbalanced motor	Disconnect load and operate motor. If motor still vibrates, rebalance rotor.
	Bent Geareducer shaft	Check fan and pinion shafts with dial indicator. Replace if necessary.
Scale or Foreign Substances in Water System	Lack of, or insufficient, blowdown	See "Water Treatment" section of this manual.
	Water treatment	Consult competent water treating specialist. See "Water Treatment" section of this manual.

**IMPORTANT INSTALLATION INSTRUCTIONS
FOR MODELS 8608, 8609, 8610 AND 8614.**

FAN SHOULD BE IN OPERATING POSITION BEFORE INSTALLING UPPER FAN CYLINDER SEGMENTS. BE SURE FAN TURNS FREELY IN CYLINDER, ($\frac{1}{8}$ " MINIMUM TIP CLEARANCE) AFTER SEGMENTS ARE BOLTED IN POSITION.



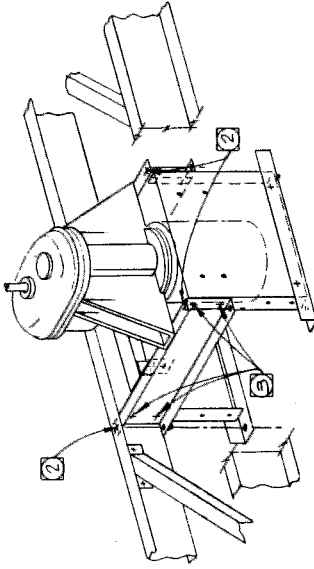
VIEW B-B
(96 DIA. - 2 PIECE
GUARD ONLY)
(TYP. 4 PLACES/FAN)



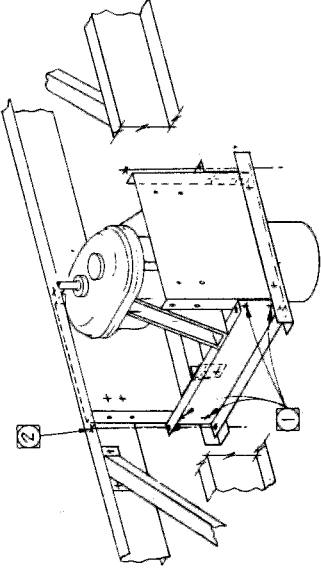
ELEVATION AT FAN CYLINDER

$\frac{3}{8}$ x $\frac{1}{2}$ S.S. M.B.
WITH 2 S.C. WASHERS,
1 LOCKWASHER, 1
S.S. NUT.
(9 PLS./84" FAN)
(12 PLS./96" FAN)

$\frac{3}{8}$ x 1 M.B. WITH 2 S.C.
WASHERS, 1 LOCKWASHER,
1 NUT.
(24 PLS./84" FAN)
(20 PLS./96" FAN)



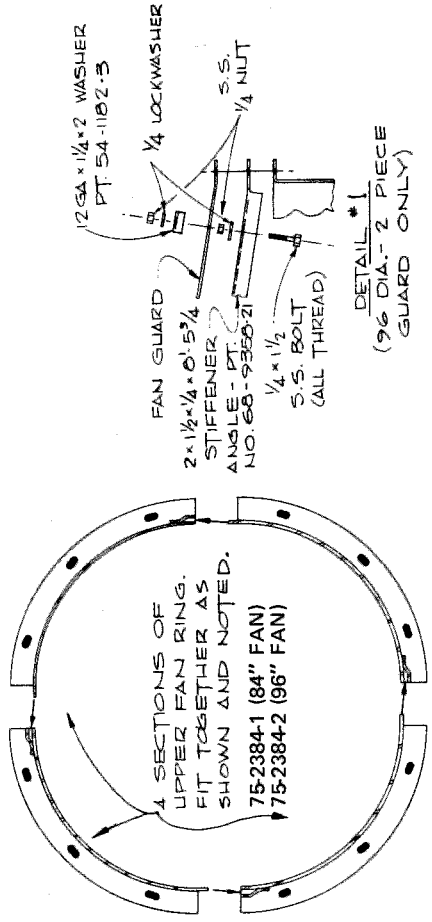
MECHANICAL EQUIPMENT IN RAISED, OR
OPERATING POSITION



MECHANICAL EQUIPMENT IN LOWERED, OR
SHIPPING POSITION

TO RAISE MECHANICAL EQUIPMENT FROM SHIPPING TO
OPERATING POSITION:

- 1 REMOVE THESE 6 BOLTS. RETAIN THEM TO BE REUSED IN STEP 3.
- 2 TIGHTEN THESE 4 ALL THD BOLTS EVENLY TO RAISE MECHANICAL EQUIPMENT. NOTE: IF THESE BOLTS ARE NOT TIGHTENED EVENLY, MECHANICAL EQUIPMENT WILL NOT REMAIN LEVEL, AND WILL BIND.
- 3 INSTALL THE 6 BOLTS REMOVED IN STEP 1 AT THIS LOCATION AFTER MECHANICAL EQUIPMENT IS RAISED.



SECTION A-A

FAN CYLINDER AND FAN GUARD INSTALLATION NOTES:

1. SLIP SECTIONS OF UPPER FAN RING TOGETHER AS SHOWN, AND BOLT IN PLACE WITH $\frac{3}{8}$ x 1 BOLTS WITH 2 S.C. WASHERS, ONE LOCKWASHER, AND NUTS.
2. INSTALL FAN GUARD AS SHOWN.
NOTE: 96 DIA. FAN HAS 2 PIECE GUARD WITH STIFFENER ANGLE AND CLIP WASHERS, 84 DIA. FAN HAS ONLY A ONE PIECE FAN GUARD